

### ATTACHMENT III

#### ABSTRACT

This invention teaches two new families of Si-based Ge/Sn<sub>x</sub>Ge<sub>1-x</sub> heterodiode and multiple quantum well (MQW) photonic devices: (1) *band-to-band* photodetectors, lasers, emitters, amplifiers and modulators for the 1.5 to 12  $\mu\text{m}$  wavelength range; (2) *intersubband* photodetectors, lasers, emitters and modulators for 12 to 100  $\mu\text{m}$  operation. The bipolar band-to-band devices have applications within the 1.5-2.2, 3-5 and 8-to-12  $\mu\text{m}$  bands. The unipolar intersubband group has longwave infrared and terahertz applications. All strained-layer devices are grown a relaxed Sn<sub>y</sub>Si<sub>z</sub>Ge<sub>1-y-z</sub> buffer layer-- a virtual substrate (VS) grown directly upon a silicon wafer by unique LT UHV-CVD. The VS provides a low-defect atomic template for subsequent heteroepitaxy and is an essential enabling technique for engineering tensile and compressive strain within the Ge/Sn<sub>x</sub>Ge<sub>1-x</sub> MQW by selecting the VS lattice parameter to be approx midway between the layer lattices.